Citation:

Sinha R, Cross AJ, Graubard BI, Leitzmann MF, Schatzkin A. Meat intake and mortality: a prospective study of over half a million people, *Arch Intern Med.* 2009 Mar 23; 169(6): 562-571.

PubMed ID: 19307518

Study Design:

Prospective cohort study

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To determine the relations of red, white and processed meat intakes to risk for total and cause-specific mortality.

Inclusion Criteria:

- Age 50 to 71 years
- Participants from the National Institutes of Health-American Association of Retired Persons (NIH-AARP) Diet and Health Study.

Exclusion Criteria:

- Moved out of the area before completing the study (N=321)
- Requested to be withdrawn from the study (N=829)
- Died before study entry (N=261)
- Had duplicate records (N=179)
- Indicated that they were not the intended respondent and did not complete the questionnaire (N=13,442)
- Provided no information on gender (N=6)
- Did not answer substantial portions of the questionnaire or had more than 10 recording error (N=35,679)
- Reported extreme daily total energy intake defined as more than two interquartile ranges above the 75th percentile or below the 25th percentile (N=4,849)
- Had zero-person years following (N=140).

Description of Study Protocol:

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Recruitment

Subjects were recruited for NIH-AARP Diet and Health Study from six US states (California, Florida, Louisiana, New Jersey, North Carolina, and Pennsylvania) and two metropolitan areas (Atlanta, Georgia and Detroit, Michigan).

Design

Prospective observational study.

Dietary Intake/Dietary Assessment Methodology

A 124-item food frequency questionnaire (FFQ).

Statistical Analysis

- Cox proportional hazard analysis was used to estimate the relative risk (RR) for mortality
- To address confounding, a stepwise variable selection to include covariates to the model was done. The final model included: age, education, marital status, family history of cancer, race, BMI, smoking history and smoking status, total energy intake, alcohol intake, vitamin supplement use, fruit consumption, vegetable consumption and menopausal hormone therapy use for women
- To test the relation between meat intake and mortality by smoking status, median values of each quintile were used to test for linear trend with two-sided P-values
- Population-attributable risk were calculated to estimate the percentage of mortality that could be prevented if individuals adopted intake levels of participants in the first quintile.

Data Collection Summary:

Timing of Measurements

Baseline questionnaires were completed in 1995 and follow-up occurred through December 21, 2005.

Dependent Variables

Total mortality and deaths due to cancer, cardiovascular disease (CVD), injuries and sudden deaths. This was determined using follow-up surveys and by linkage to the Social Security Administration Death Master File.

Independent Variables

Meat intake was estimated using a food-frequency questionnaire (FFQ) administered at baseline.

Control Variables

- Age
- Education
- Marital status
- Family history of cancer
- Race
- BMI
- Smoking history and smoking status

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- Total energy intake
- Alcohol intake
- Vitamin supplement use
- Fruit consumption
- Vegetable consumption
- Menopausal hormone therapy use for women.

Description of Actual Data Sample:

- *Initial N:* 617,119
- *Attrition (final N):* 545,653 (322,263 men and 223,390 women)
- *Age:* 62 years
- *Ethnicity and other relevant demographics:*
  - Subject who consumed more red meat tended to be married, more likely of non-Hispanic white ethnicity, more likely a current smoker, have a higher BMI and have a higher daily intake of energy, total fat and saturated fat
  - They tended to have lower education and physical activity levels and lower fruit, vegetable, fiber and vitamin supplement use.
- *Anthropometrics:* BMI (27kg/m^2)
- *Location:* US.

Summary of Results:

- During 10 years of follow-up, there were 47,976 male deaths and 23,276 female deaths of all causes
- There was an increased risk of CVD mortality in both men (HR=1.27; 95% CI: 1.20, 1.35; P<0.001) and women (HR=1.50; 95% CI: 1.37, 1.65; P<0.001) in the highest compared with the lowest quintile of red meat intake in the fully adjusted model
- There was an increased risk of CVD mortality in both men (HR=1.09; 95% CI: 1.03, 1.15; P<0.001) and women (HR=1.38; 95% CI: 1.26, 1.51; P<0.001) in the highest compared with the lowest quintile of processed meat intake
- There was a small increase in risk for CVD mortality in men (HR=1.05; 95% CI: 1.00, 1.11; P=0.009), but not women (HR=1.04; 95% CI: 0.96, 1.14; P=0.19) with higher intake of white meat
- For CVD mortality, there was an 11% decrease in men and a 21% decrease in women if red meat consumption was decreased to the amount consumed by individuals in the first quintile
- The median red meat consumption based on men and women in the first quintile was 9.8g per 1,000kcal per day compared with 62.5g per 1,000kcal per day in the fifth quintile
- For women eating processed meat at the first quintile level, the decrease in CVD mortality was approximately 20%. The median processed meat consumption based on men and women in the first quintile was 1.6g per 1,000kcal per day compared with 22.6g per 1,000kcal per day in the fifth quintile.

Author Conclusion:

Red and processed meat intakes were associated with a modest increase in risk of total mortality, cancer and CVD mortality in both men and women. In contrast, high white meat intake was associated with a small decrease in total and cancer mortality.

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Reviewer Comments:

This is a well-designed, large prospective study.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	N/A
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	N/A
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	N/A
Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	N/A
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	N/A
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A

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3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	Yes
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	N/A
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	N/A
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	No
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes

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6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A

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8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	No
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes

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